THE LIFE HISTORIES OF *MUSCA AUSTRALIS* MACQ., AND *M. VETUSTISSIMA* WALKER.

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(26 Text-figures).

For some time past we have been engaged in the study of Australian diptera as transmitters of certain nematode parasites of stock. This has involved the dissection of large numbers of adults, pupae, and larvae of various species, and has necessitated a study of the life history of the commoner forms in the district (Eidsvold, Upper Burnett River, Queensland) where the work has been carried out.

On account of the inadequacy of the available descriptions of the two "bush flies" especially dealt with in this paper, we have deemed it advisable to supplement them and to add figures of the two sexes of each species.

In regard to these two species of flies, *Musca australis* Macq. and *M. vetustissima* Walker, we may state that in the Upper Burnett district they are both abundant during the summer, but during the winter the latter is rarely seen, while the former remains fairly common except during midwinter, when it becomes scarce. Neither of them occurs indoors unless attracted by the presence of dead animal matter, etc., *e.g.*, in the laboratory.

Certain other flies found in the district may be referred to. Many of the local Tabanids have been worked out by E. E. Austen, of the British Museum, and by F. H. Taylor, late of the Australian Institute of Tropical Medicine. Both of these dipterologists have kindly identified some of the flies referred to in this list. *Musca*

domestica is common in houses, but *Fannia scalaris* and *F. canicularis* have not yet been noticed, nor has *Muscina stabulans*, though the last two-named occur in Brisbane. *Stomoxys calcitrans* is decidedly scarce in the bush, but common in the vicinity of stables in certain outlying districts. Though there are plenty of suitable breeding places in Eidsvold, yet specimens of the species have not been noticed in the township Amongst blowflies one notes that *Anastellorhina augur* Fabr. (syn. *Calliphora oceaniae*) is very common right through the year, while others which occur in the district are *Neocalliphora ochracea*, *Pollenia stygia* Fabr. (syn. *Calliphora villosa*), and the metallic blowflies *Lucilia sericata*, *Calliphora incisuralis*, *Pycnosoma rufifacies* and *P. varipes*. Belonging to the Anthomyidæ are *Ophyra nigra*; also a small black *Fannia* sp., very commonly seen on stock; and, in addition, a slightly larger slaty grey species (*Fannia* sp.) which is rather uncommon—both of these breeding in cowdung, while *Oph. nigra* is one of the "sheep maggot flies." There is also a rather small blowfly (*Lasiopyrellia*) of a bright metallic green colour (like that of a *Pycnosoma*) when alive, but changing to a fine cobalt blue in from one to two days after death. This species is rather broader and shorter than typical examples of *M. australis*. It deposits its eggs in cow manure. Also ovipositing in the same material is a very small blowfly (probably a *Pseudopyrellia*) resembling the *Lasiopyrellia* in colouration when alive, but when dead the blue is less intense and slightly greenish, and the wings more iridescent. This fly possesses habits similar to those of *Pseudopyrellia australis* mentioned by Cleland (1913, p. 566). *Sarcophaga misera* Walker is common, especially during summer. In addition to the above one might mention the presence of a Muscid, *Musca* sp. indet., which is rare in the locality and lays its eggs in horse dung.

MUSCA AUSTRALIS *Macquart.**

(Text-figures 1, 4, 7, 10, 12, 16, 18, 20, 23, 24, 25.)

The original description (Macquart, 1842, p. 152), is as follows:—

*See Addendum regarding this specific name.

Musca australis, Nob. Voyage autour du monde, de M. Leguillon. ♂ Fronte sublarga. ♀ Cinerea. Thorace quadrivittata. Abdomine nigro tessellato. Squamis flavidis. Nervo transverso cellulae discoidalis subrecto. (Tab. 20, fig. 10).

Long. 31. ♀. Semblable à la *M. corvina* ; elle n'en diffère que par les cuillerons un peu jaunatres au lieu de blancs, et par la nervure terminale de la cellule discoidale des ailes, qui est presque droite au lieu de sinueuse.

Des îles Salomon et des îles Viti.

Male : Front etroit que dans le *M. corvina.* De plus, les mêmes différences specifiques que dans la femelle.

De Hobart-Town, dans la Tasmanie, et de Vanoo, aux îles Víti

Un individu ♀ a l'abdomen dépouillé de duvet. Une variété du mâle a l'abdomen fauve seulement sur une petite partie des côtes.

Une variété a l'abdomen fauve comme le mâle, avec une ligne dorsale noire.

The general colour is lighter than that of the house fly*. The normal length of both sexes is 7 mm. When at rest the wings of the male lie obliquely in relation to the plane of the body, the costa being raised : those of the female lie closer to the body.

General habits. The flies† frequent cattle and horses, clustering round the eyes, mouth and nostrils, and any

*To simplify comparisons we have taken as a standard description that given by Graham-Smith for Musca domestica, 1914, p. 19.

For our drawings and descriptions of colouration we have examined specimens with the posterior region of the animal towards the light. We deem it necessary to make this statement since if the insect be viewed with the light from the opposite quarter then very often the parts which were light coloured in the first instance become dark, and *vice versa.* This is particularly obvious in the case of the thoracic stripes but also holds good for certain other structures, including the frontal stripe and adjacent frons.

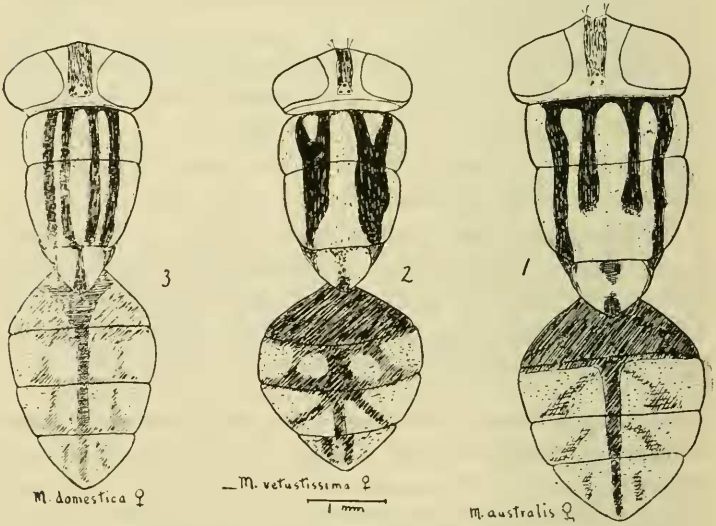
†These flies may be parasitised by larval mites, a red one probably *Acarus muscarum* Linn. and also a minute whitish species.

sore or abrasion of the skin. They suck the weat and mucus and also blood if a raw surface is available. They alight on fresh dung for feeding purposes as well as for the deposition of larvae.

Male.

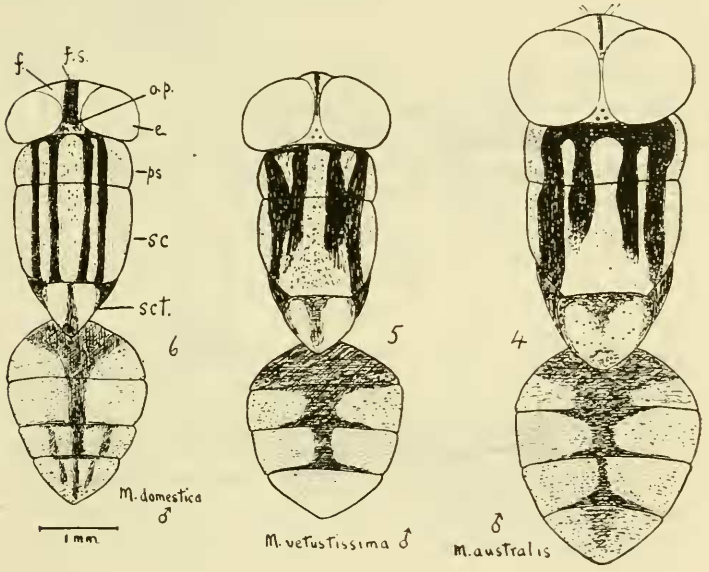
Head. The eyes practically touch for a considerable distance, the ocellar tubercle being closely hemmed in between the inner and posterior borders of the eyes and separated from them by a very narrow silvery stripe. The black frontal stripe is extremely narrow.

Frontal margin of the eye practically obliterated. Cheeks and face silvery. Antennae dark silvery-grey. Aristae black and feathered (fig. 10) very like those of the house fly. Palps black.



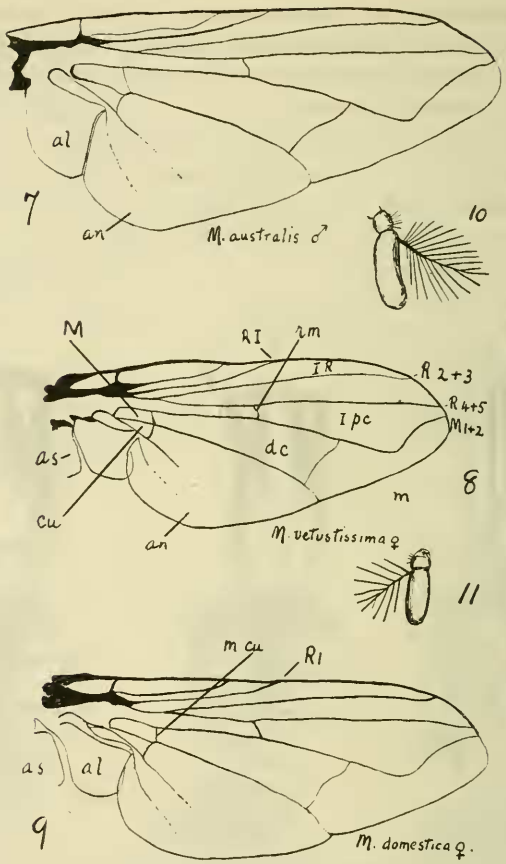
Thorax. If the light comes from the anterior end the general effect is black, but if viewed from the opposite quarter it is silver-grey with four well-defined black longitudinal bands, the outer ones on each side extending to the end of the scutum, whilst the two median bands reach to the vicinity of the middle of the scutum but may be continued a little further and may merge into the lateral lines.

The latter on the prescutum generally diverge outwardly (fig. 4). The scutellum is silvery-grey with a black triangular patch at its anterior border, the apex of the triangle directed backwards. There is also a faint dark marking at the posterior end of the scutellum. It is not proposed to refer to the chaetotaxy, though the fly is very hairy.



Wings. The wings are clear, and the veins pale brownish-yellow towards the base. The venation is figured in fig. 7. The wing is a stouter and broader structure than that of the house fly. The radial longitudinal nervure R 4+5 is nearly straight, as is also R 2+3.

Macquart (p. 153, pl. 20, fig. 10) states that the nerve of the discoidal cell, *i.e.*, the medial transverse nervure bounding the first medial cell, is almost straight. It is, however, slightly sinuous and approximates that of *M. domestica.* The medio-cubital transverse nervure is relatively long and more inclined than in *M. domestica.* The medial cell is somewhat differently shaped as will be seen on comparing figs. 7 and 9. The alula is relatively slightly larger than in the house fly.



EXPLANATION OF LETTERING.

a. anus; *ac.g.* accessory gland; *al.* alula; *an.* anal lobe of wing; *as.* antisquama; *a.sp.* process of anterior spiracle; *c.e.*. clear envelope surrounding process of anterior spiracle; *cg.g* conglobate gland; *c.r.* chitinous rim of spiracle; *cu.* cubital cell; *d.c.* discal cell (=first second-medial cell); *e.* eye; *f.* frons; *f.s.* frontal stripe; *M.* medial cell; *m.* medial transverse nervure (posterior cross vein); *M* 1+2 median longitudinal vein (fused first and second); *M.cu.* medio-cubital transverse nervure; *mus.* muscle; *n.c.* nurse cell of ovum; *o.* ovary *od.* oviduct; *od.c.* common oviduct; *o.f.* ovarian follicles; *o.p.* ocellar plate or tubercle with three ocelli; *o.t.* so-called optic tubercle; *ov.* ovum; *ov.d.* developing embryo. *I.pc.* 5th radical cell; *ps.* prescutum; *R I.* first radial longitudinal vein; *R* 2+3 fused 2nd and 3rd rad. longit. vein; *R* 4+5 fused 4th and 5th; *r.m.* radial median crossvein (discal nervure, anterior transverse vein); *S* 2 spiracle of second instar; *S* 3. spiracle of third instar; *sc.* scutum; *sct.* scutellum; *sp.* spermatheca; *sp.p.* spiniferous pads; *s.s.* spiracular slits; *tr.* trachea; *ut.* uterus.

The squame is pale grey posteriorly shading to yellowish-grey anteriorly. The halteres are pale yellow and are covered by the squame.

Legs. The legs are very dark brown, practically black, with pale foot cushions.

Abdomen. The general colour viewed dorsally from behind is light yellowish-brown. When viewed microscopically the margins are seen to be silvery with prominent brown golden blotches laterally separating the silvery margins. The anterior part and mid-dorsal portion of the first segment are dark brown, the remainder of segment a paler brown. Succeeding segments are dark brown along the mid line but the colouration is not so pronounced in the last segment. The under surface of the abdomen is yellow with dark brown markings at the posterior end in the vicinity of the genital aperture.

Female.

The female differs from the male in the following particulars :—The eyes are separated by a space equal to about a-third of the width of the head, this inter-ocular region being occupied by the wide pale golden frontal margins and the wide dark brown frontal stripe. The black bands on the thorax are rather narrower than those of the male and consequently the general colouration is lighter.

The first abdominal segment dorsally is practically black, while there is a median dark, more or less continuous, band on the remaining segments with dark brown blotches lying laterally. The general effect is shewn in fig. 1. Ventrally the colouration resembles that of the male.

Breeding habits. The species is a larviparous one, one larva being deposited at each birth. The flies frequent isolated patches of fresh cow-dung for larviposition. They will also deposit larvae on horse-dung, but less frequently as the latter substance is usually drier, coarser and more friable, therefore forming a less suitable nidus for the developing larvae. The flies show considerable discrimination in the choice of a suitable patch of cow-dung, selecting that which is of thinner consistency in preference to that

which, though fresh, is naturally drier and harder. Thus scores of flies will visit the former for larviposition in comparison with one or two visiting the latter. This instinct is of great value to a fly which has to contend with excessive heat and aridity.

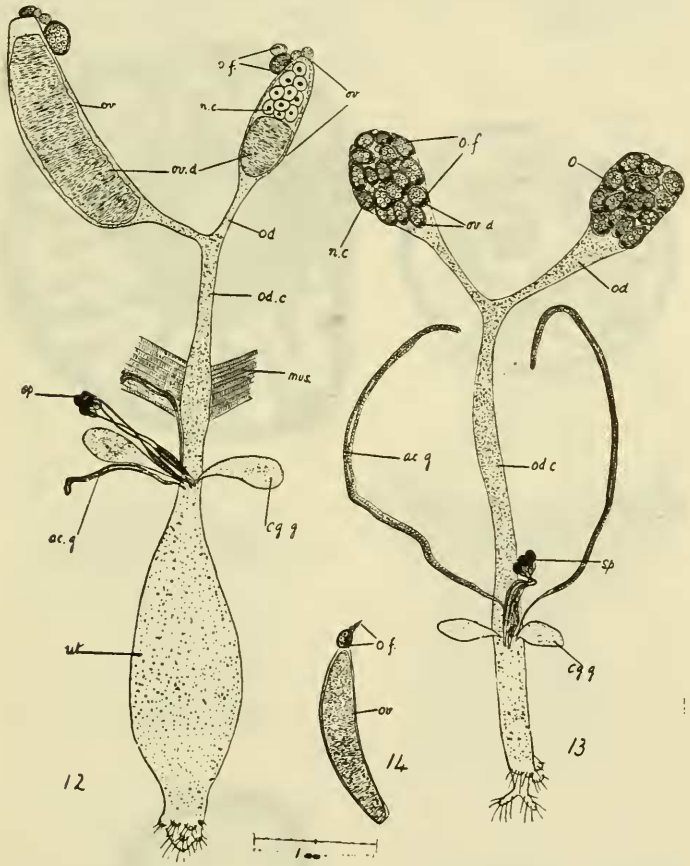
We have found *M. australis* breeding naturally only in cow and horse dung. Under experimental conditions, flies deposited larvae on wallaby dung and larvae reared at first in cow manure, when transferred to wallaby faeces, bred out. We do not think that the pellets of wallaby dung under ordinary conditions serve as a suitable nidus, but when they become broken up and moistened with water. then, as we have observed, larvae can be reared to maturity from such material.

We have bred out specimens from bird excrement collected on the wet sand along the edge of the Burnett River, early larvae having first been transferred to a mass of such material from cow manure. Fowlyard manure does not seem to offer a suitable nidus for *M. australis*, though *M. domestica* as well as blowflies visit it for ovi- or larviposition.

As cattle and horses have been introduced into Australia, some other material than their manure must previously have served as the natural breeding place of *M. australis* as well as *M. vetustissima*. Probably it breeds in decomposing vegetation, as the latter under the name of *M. corvina* has been reported to do.

Genital system. The genitalia of the female differ from those of *M. domestica* and resemble those of *M. bezzii* described and figured by Patton and Cragg (1913, p. 140, and pl. xxx, fig. 2). Each ovary consists of a single ovariole ; the ovarioles functioning alternately in passing an ovum into the uterus or terminal portion of the common oviduct which is greatly enlarged in this species. The relationship of the various parts will be best understood by reference to fig. 12. The two conglobate glands or accessory copulatory vesicles are comparatively large while the accessory glands are relatively much shorter than those of *M. domestica* (Hewitt., p. 49, figs. 20, 21), being of about the same length as the three spermathecae. The latter

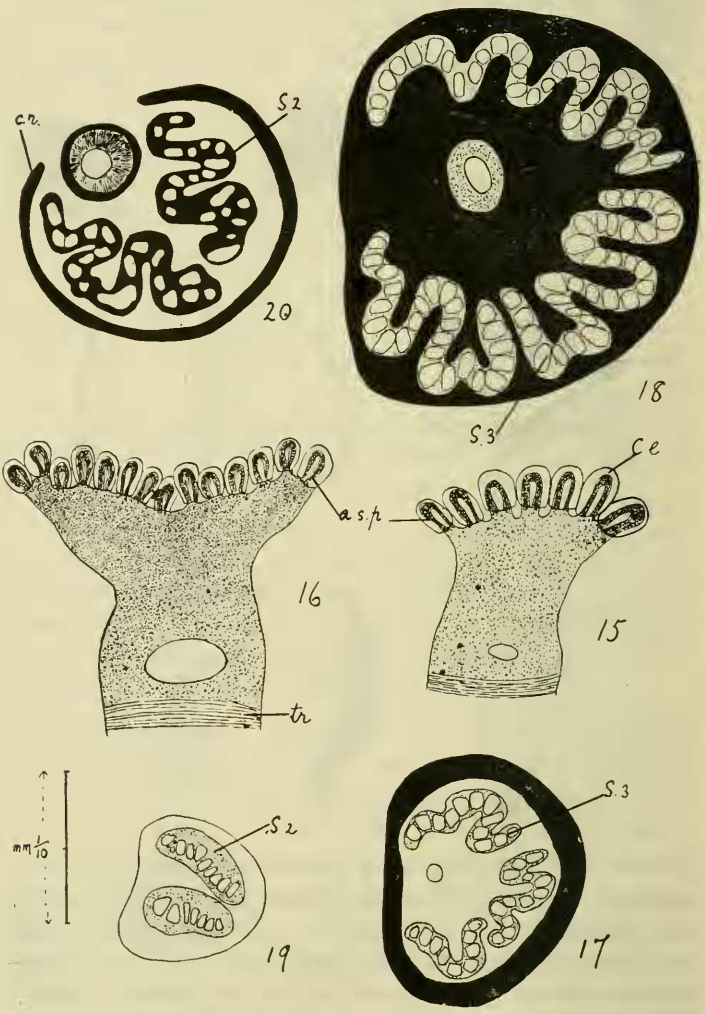
have the same general arrangement and structure as in *M. domestica*. Attached to the common oviduct above the point of entry of the various accessory glands there is a strong band of muscle which probably assists in supporting the more posteriorly situated parts of the system.



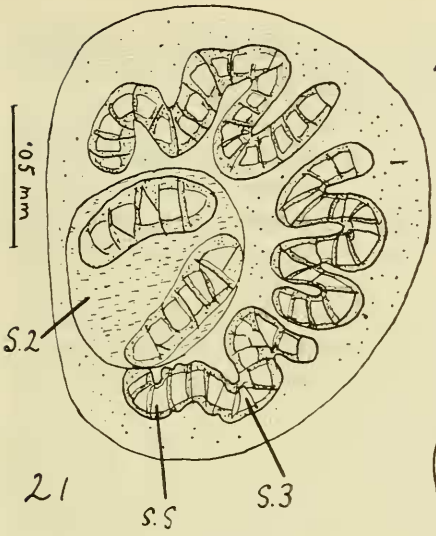
The wall of the uterus is composed of large cells with prominent nuclei, the cell cytoplasm not staining readily with Delafield's haematoxylin. If the uterus be crushed a fat-like emulsion is obtained, this probably being material for the nourishment of the developing embryo. The ovipositor is markedly abbreviated.

Larva. The first larval instar is passed through within the uterus of the parent and measures about 1.5 mm. in length.

Its posterior spiracles are in form of two small dark-brown projections each with an opening at its summit. There are no anterior spiracles. The second instar is marked by the appearance of the anterior spiracles each of which contains 11 to 14 processes (fig. 16). The posterior spiracles are much larger, a black chitinous D-shaped structure



appearing round the original knob, and containing two sinuous slits (fig. 20). At this stage the larva is deposited by the female, but is still enclosed in its thin, delicate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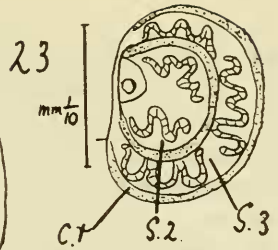
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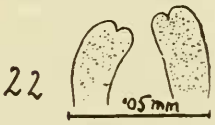
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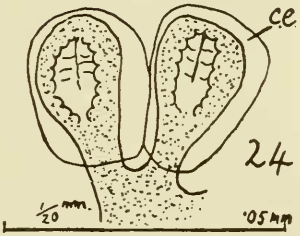
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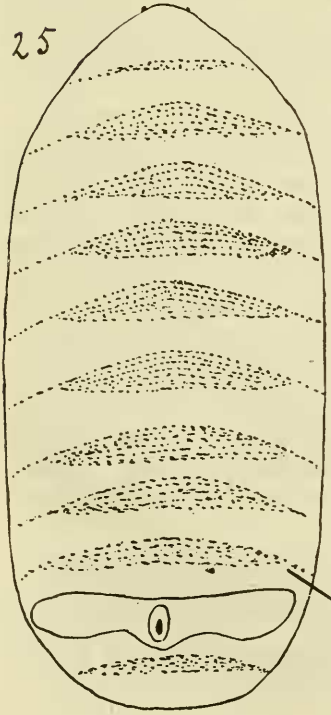
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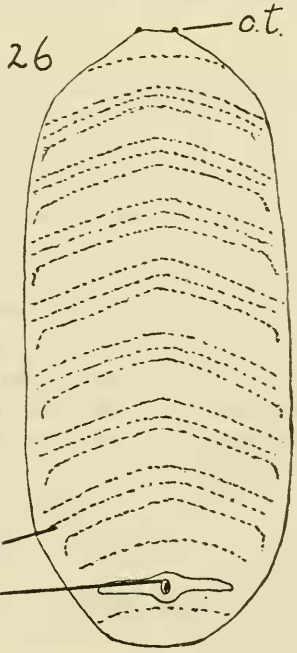
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eggshell.* A few active movements of the larva, however, suffice to split the shell longitudinally, and the escaping larva burrows rapidly into the dung.

In hot weather the larvae grow very rapidly and have usually finished feeding by the end of the second day and have pupated by the third day after deposition. Fully formed pupae have been found occasionally on the second day after deposition. In winter the larval stage is prolonged to about six days. During the beginning of October, when the larval stage was occupying four days., the following periods were noticed and measurements of the larvae made. The larvae were fixed in nearly boiling water and preserved in formalin.

The larva at birth measures 3.5 mm. long by 1 mm. and is in the second instar. During the first 24 hours it grows enormously and at the end of that period measures 7.5 to 9 mm. by 1.5 to 2 mm., by which time it is usually moulting. The anterior spiracles increase in size and each contains 13-17 processes ; the posterior spiracles also increase greatly in size and issue in three much convoluted slits (fig. 18). The chitin is thicker and blacker. These large black spiracles are rather characteristic of the larva. On the second day it measures 11 mm. by 2.5 mm. attaining on the third day its maximum size, now measuring 11.5-13 mm. in length by 2.5 to 3 mm. in breadth ; on the fourth day the larva is mature, ceases feeding and shrinks somewhat in size, measuring 10-11 by 2.5 mm. ; the alimentary tract becomes emptied of food and the larva assumes a pale yellow colour with a deeper yellow patch on the anterior dorsal surface. At this stage the larva burrows up to the surface of the dung, then retreats a short distance—about half an inch—in its burrow and pupates, with the hed end pointing outward. Under laboratory conditions the larvae will leave the dung and pupate in damp sand.

The puparium measures 7 to 7.5 mm. by 2.5 to 3 mm., and is at first yellowish grey in colour becoming dark grey

*In one case an *egg* was laid in captivity. This, however, is quite exceptional.

as the development of the fly proceeds. When the imago emerges, it crawls out of the burrow, pushing any loose debris aside by inflating and deflating its ptilinal sac. In summer at Eidsvold, Burnett River, Queensland, the pupation period is from 9-15 days ; in winter 27-32 days These periods were observed under laboratory conditions without artificial heating and are probably longer than would obtain under natural conditions owing to the higher day temperatures outside.

Of a given batch of larvae deposited by flies on the same day, females will, as a rule, be the first to emerge, then follows a period in which both males and females appear, and then a period in which only males emerge. There is usually a slight preponderance of males among bred flies, thus for over 300 flies bred out, the percentages were, males 57 % and females 43 %. When flies are captured on stock the males are decidedly in the minority, since out of over 500 captured flies, only 7 % were males. Froggatt's (1916, p. 10) observations regarding blowflies in New South Wales were somewhat similar, he having found that among captured flies only about 3 % were males.

Often large numbers of flies may be bred from a single isolated dropping of cowdung ; thus one such deposit yielded 120 flies (70 males and 50 females). It must be remembered that a female fly deposits only one larva at a time, hence at least 120 females must have visited the mass for larviposition. Flies which have been bred and kept in captivity have never been observed to copulate or deposit larvae though both sexes were present. Perhaps copulation does not occur under such circumstances, as sperms have not been found in the spermathecae of such flies. In one insect which was kept in captivity for two months two equally developed ova were found in each ovary but there was no larva in the uterus. Attempts to discover the period between emergence and larviposition, and also between successive larvipositions have not been successful. Captured female flies will readily deposit one larva, but have not been observed to do so a second time.

Particular notice of the number of follicles was not taken but in the specimen drawn (fig. 12) there was a larva

in the uterus, a developing egg and four follicles on each side. Thus the total was eleven, the twelfth must have been already born. We may then assume that the possible number of larvipositions is at least twelve.

Patton and Cragg (1913, p. 130-139) discuss the pupiparous habit among flies. There are three distinct degrees of this habit. In many Tachinids which are not blood-suckers the larvae are delivered almost as soon as they hatch out of the egg. They undergo little or no development in the uterus and are laid in a large batch exactly as eggs are laid. The next degree is instanced by two cases *M. corvina* Fab. var. *vivipara* Portschinski and *M. bezzii* Patton and Cragg which are both blood feeders. Here the larva is retained and nourished for part of its life in the genital tract of the female but is deposited while still young and completes its growth under conditions similar to those of its allies. We may now add *M. australis* to the category. In the third degree the larva is retained until it is ready to pupate, *e.g.*, *Glossina* and *Hippobosca*.

The authors then go on to discuss the reasons for the acceleration of the larval stages. In the Tachinids it is due to the fact that the food is usually the living larvae of other insects. The larval stage of the parasite must be complete before, or soon after, the host pupates lest the food supply be exhausted. In the other two cases there is no such obvious explanation, and it is probable that two factors enter into it. Firstly, the advantage of having the young larva protected within the body of the parent; and, secondly, the rich food supply obtained by blood sucking insects appear to have some relation to the pupiparous habit. The number of pupiparous forms is high in comparison with the number of blood-sucking forms. The authors state that "the subject is a very obscure one, but the association of the blood-sucking habit with the pupiparous habit is clear enough, and one should always be on the look out for larviparous forms among those known to suck blood, whether they are biting flies or not." *M. australis* is not dependent on blood for a living, but lives on any secretion; it will, however, greedily suck the blood and juices from a sore or wound.

We would like to point out that in the case of blowflies the larviparous habit is not necessarily associated with blood-sucking. Besides, mosquitoes and Tabanids, which are blood-suckers, do not practise larviposition.

Musca vetustissima *Walker*.

(Text-figures 2, 5, 8, 11, 13, 14, 15, 17, 19, 21, 22, 26.)

As far as we are aware the male has not been described. The following is Walker's original description (1849, p. 902) of the female. It has also been quoted by Cleland (1913, p. 18-19).

"*Musca vetustissima* n.s. fem.—Cana, capite albo micante, thoraci vittis duabus latis nigris, abdomine canocinereo, palpis nigris, antennis piceis basi nigris, pedibus piceis, alis limpidis basi albis. Body hoary, clothed with black hairs and bristles; head adorned with white lustre; a black stripe between the eyelets and the feelers; epistoma not prominent; sides of the face feathered with bristles at the base; eyes red; fore part flat, its facets a little larger than those elsewhere; sucker pitchy, clothed with tawny hairs; palpi black, beset with black bristles; feelers black, a little shorter than the face; third joint pitchy, linear, rounded at the top, about thrice the length of the second joint; chest adorned with two broad black stripes; abdomen obconical, grey, with hoary reflections, a little broader, but not longer than the chest; legs pitchy, clothed with black hairs and bristles; foot-cushions tawny; wings colourless white at the base; wing-ribs and vein pale tawny; veins darker towards the tips; tip cross-vein forming an obtuse angle with the fourth longitudinal vein, very slightly inclined inwards along the whole length, joining the border a little above the tip of the wing; lower cross-vein nearly straight; squame white; poisers pale yellow. Length of the body 2 lines; of the wings 4 lines. New Holland. . . . . ."

M. vetustissima is a fly with a dark body and very lightly coloured abdomen in the case of the male, but with a dusky abdomen in the female. The length of a normal male or female is about 6 mm. though one may frequently meet with very small specimens ranging in

length from 3.5 mm. upwards. The length given by Walker in his original account suggests that he was dealing with under-sized material.

In the case of the female the wings, when at rest, overlap to a greater extent than they do in *M. australis*, whereas the position is alike in the males of both species.

Male.

Head. The eyes are very close, particularly in one region where they are separated only by the frontal stripe, the later being dark grey. Face and frontal region silvery but the latter does not extend dorsally beyond the point where the eyes approximate most closely ; it is therefore practically unrepresented in the region of the ocellar tubercle. Antennæ brown with silvery tints. Arista (fig. 11) plumose somewhat as in *M. domestica*. Palps black.

Thorax. The thorax is dark and shiny when lighted from the front. When the light falls on it posteriorly broad black bands can be seen. There are really four of these but the two of each side become more or less fused so that it is only in the prescutum that the four are usually recognisable. In the scutum there is a very broad band on each side especially anteriorly, while in the posterior part of scutum only the lateral band of either side is represented, These bands are joined together in the extreme anterior end of the prescutum. The central silver-grey band is variable in form. its sides being at times subparallel, while at other times they converge anteriorly so that the stripe resembles an elongate triangle. One then usually recognises the central silver-grey band, a lateral silver-grey band on either side and vestiges of silver-grey bands in the anterior part of the prescutum—one on either side. The scutellum has a darker patch in its anterior region and one at its extremity as well as a lateral pair (fig. 5).

Wings (fig. 8). The wings are clear throughout. Each is relatively shorter than *M. domestica*. The nervure R 4+5 is almost straight like that of *M. australis*. The first posterior cell is relatively shorter and the distal bent portion of nervure M 1+2 is rather more bent than in *M. domestica*, while the angle approaches much more nearly to the hinder border of the wing. The median transverse

vein is almost straight. The discal nervure is distinctly curved with the concavity facing towards the base of the wing. The alula is rather more rhomboidal than that of *M. domestica*. The squame is very pale or whitish. Halteres are long and yellowish. The legs are black.

Abdomen. The first segment is black with colouration extending backwardly as in fig. 5, forming a fairly broad median stripe with lateral extensions in the hinder portion of each segment, these varying in different individuals. The greater part of the dorsum of the abdomen is of a pale golden hue which stands out in sharp contrast with the black median band. The abdomen is densely setose. Ventrally it is yellowish with black colouration in the region of the genital aperture.

Female.

The general appearance of the female is markedly different from that of the male, chiefly on account of the tessellated appearance of the abdomen dorsally, while ventrally it has a more or less uniform smoky-grey colour. The thoracic region is distinctly greyer. The fly then appears to have a rather lighter coloured thorax and a darker abdomen than the male. The main points of difference are as follows: Eyes widely separated by a distance approximating a-third of the width of the head; a broad frontal stripe about half the width of the area between the eyes: the frontal margins extending upwards on either side of the frontal stripe downwards as a very distinct silvery band on either side of the antennæ.

Thorax. The thoracic markings are arranged much the same as in the male, similar variations also being met with (fig. 2).

Abdomen. The markings on the dorsal surface of the abdomen are characteristic—their arrangement being indicated in fig 2. The first segment is black On succeeding segments there is a median dorsal stripe resembling that of the male, but there is laterally on each segment a dark band extending somewhat obliquely from the anterior to the posterior margin of each segment. The pigment patch on the first segment commonly invades the anterior portion of the succeeding segment.

General Habits. Like *M. australis* this species lives in association with cattle and horses. It is, however, a more troublesome fly to man, attaching itself to his person and making persistent attempts to reach the eyes. Dr. Cleland (1913, p. 565) has described the habits of this fly, which is essentially an outdoor species and is very rarely found within the house. It has been found in abundance feeding on the blood and pus from sores on the heads of sheep. If one ventures outside in the warm weather this species soon attaches itself to one's person and that part of one's clothing (especially if black) which is sheltered from the wind may be covered with a dense mass of these insects. They render themselves especially annoying by hovering around and finding their way into one's eyes, nose and mouth. The abundance of the fly makes it likely that if epidemic conjunctivitis and trachoma are transmitted by flies this is the species likely to be incriminated. Cleland (1913, pp. 560-2) has referred to the intense annoyance experienced by early Australian navigators and explorers as a result of attacks by myriads of flies which he believed to have been *M. vetustissima.* He has shown that it can feed on dried anthrax blood and that the bacilli pass unharmed through its alimentary canal (p. 565). Owing to its habits, the species could no doubt set up anthrax infection.

Mr. G. F. Hill, F.E S., of the Australian Institute of Tropical Medicine, Townsville, wrote to us stating that this species is responsible for the serious condition of horses' eyes in the gulf country of the Northern Territory.

Specimens have been collected in numerous localities in Western Australia, Northern Territory, Central Australia, South Australia, and Victoria by Mr. G. F. Hill. It occurs commonly in Queensland, New South Wales, Victoria and Tasmania. We have captured it on board ships travelling between Brisbane, Sydney and Melbourne. In the last named city, the species occurs in immense numbers in the streets, making itself a nuisance to human beings and horses.

Breeding habits. It is an oviparous species—the female laying her eggs in fresh cow or horse dung, usually the former, only a limited number, 20 to 40, being deposited

at one time. The eggs are large in comparison with the size of the fly, measuring 1.5 mm. by 0.4 mm. The female organs resemble those of *M. domestica* but the maximum number of ovarioles observed in each ovary was 20 (fig. 30). The accessory glands are very long. The oviduct is a more muscular structure than that of *M. australis*. There is a long ovipositor.

The eggs are laid in a mass and placed below the surface of the dung. The egg shell is a thin, delicate structure covered with minute hexagonal markings. In warm weather the eggs hatch in less than 24 hours after deposition. The larva emerges as a first instar measuring 2 mm. by 4 mm. It grows rapidly and in a few hours moults. The second larval instar is marked by the appearance of the anterior spiracles each containing 6 to 8 processes. The posterior spiracles are now in the form of two almost straight slits (fig. 19). In 24 hours the larva measures 5.5 mm. by 1 mm. It now moults for the second time, the anterior spiracles enlarge (fig. 15), likewise the posterior pair, which are now in the form of three sinuous slits surrounded by a black chitinous rim (fig. 17). During the next day the larva increases greatly in size, measuring 10 mm. by 1.5 mm. No further appreciable growth takes place and by the fifth day the larva is mature and has entered upon the resting stage. The alimentary canal becomes emptied of food. The larva is now of a pale yellow tint and has become somewhat shorter and stouter, measuring 8.5 mm. by 2 mm. The puparium is yellowish brown to brown and measures 5 to 5.5 mm. by 2 mm. The pupal period occupies about 6 days in the summer and 10 to 14 days in the winter. The larvae pupate in the dung, but under laboratory conditions, at least, will leave it to do so.

Relationships of *M. australis* and *M. vetustissima*.

It appears that *M. australis* Macq., *M. bezzii* Patton and Cragg, and *M. corvina* Fabr., var. *vivipara* Portschinski are closely related flies. *M. bezzii*, a very common fly in certain parts of India, described and figured by Patton and Cragg (p. 352 and pl. xlv, fig. 2), is apparently very like *M. australis* in size and colouration. It is also a larviparous species depositing one larva at a time on cow dung.

The mature larva is greyish-white with a lemon-yellow dorsum, while the puparium is of a dirty grey colour with a yellowish tinge. The female genitalia, however, are slightly different from those of *M. australis*, there being only one pair of accessory glands which are stated to be larger than those found in oviparous forms. *M. corvina* var. *vivipara* closely resembles *M. bezzii* but its puparium is dark brown. It is common in Europe and parts of Northern Africa.

M. corvina Fabr. var. *ovipara* Portschinski, on the other hand, is evidently close to *M. vetustissima* Walk. The size and markings are similar. According to Portschinski the former lays 24 eggs on cow dung, each egg being 1.5 mm. long and possessing a delicate dark spine 2/3 of its length. The puparium is white. It seems likely, as Patton and Cragg remark, that Portschinski confused two closely allied muscids, one larviparous and the other oviparous.

There are a number of references to *M. corvina* Fabr. in Australian literature. Froggatt in his work on Australian Insects (1907), mentions this species and states that it is the common bush fly swarming from the eastern coast to the interior, also having a wide range over Europe, North America, Ceylon and Malay Archipelago. It is a darker tinted species than the house fly and shows only two parallel bands on the thorax. A figure of the fly is given on Plate 29, fig. 5.

Froggatt (1915, pp. 27-28), again mentions *M. corvina* as the common bush fly. He gives a short description of both sexes and states that it was found breeding in decaying vegetable matter, in the decaying mass in the paunch of most of the dead animals (sheep) that were examined, and also in horse dung from the Yarrawin horse yards, New South Wales. On 27th February, 1914, 200 specimens were caught in the tent, examination shewing that 198 were females, these containing eggs ranging in number from 22 to 35. Froggatt's description would apply equally well to *M. vetustissima* and there is little doubt but that this is really the species under discussion.

Graham-Smith (1914, p. 22) describes *M. corvina*, the size and markings being similar to those of *M. vetus-*

tissima, but the arista is slightly different, the terminal fourth not being feathered. He states that it resembles the house fly in general appearance, but the male has a yellow abdomen, with very distinct black longitudinal stripe, and the female a chequered abdomen.

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Addendum.

We have been informed recently by Dr. E. W. Ferguson, who is a worker in Australian dipterology, that Macquart's specific name *M. australis* is preoccupied by *M. australis* Boisduval (Voyage de l'Astrolabe, 2, 1835, p. 669) given to a quite different muscid. The name then cannot stand. Macquart's short account of the female was based on specimens from the Solomon and Fiji Islands, and that of the male on flies from Tasmania and Fiji. His description is very short and might include *M. vetustissima* also, except for the " quadrivittate thorax." The " black tessellated abdomen " is more characteristic of the latter species than it is of *M. australis*. We should not be surprised if more than one species be included in the scanty account. We therefore propose to name that species which occurs in Queensland as *M. fergusoni* n.sp. Should the fly from Fiji and the Solomons be shown on re-examination to be specifically identical with the Queensland forms, the name will still stand owing to Macquart's use of a preoccupied specific name, but if found to be different then a new name must be given to the Pacific species. Macquart's Tasmanian forms are probably *M. vetustissima*. We might mention that Mr. E. Austen, of the British Museum, identified some of our Eidsvold specimens as *M. australis* Macq.

Our creation of a new species rather than the renaming of the old species seems to be the most satisfactory method of dealing with the difficulty so that the synonymy in view of our present knowledge might be indicated thus, *M.*

fergusoni Jnstn. and Bancr. Syn. *M. australis* Macq. 1842 non Boisduval 1835, in part ; *M. australis* J. and B. (in the preceding portions of this paper).

Types and typical specimens will be deposited in the Queens and Museum, Brisbane, and the Australian Museum, Sydney.

TEXT-FIGURES 1-3.

Camera lucida outline drawings of female specimens to show disposition of pigment dorsally. Figures 1 to 6 have been drawn to same scale.

Fig. 1. *Musca australis* ; fig. 2. *M. vetustissima.*
Fig. 3. *M. domestica* (Brisbane specimens).

TEXT-FIGURES 4-6.

Fig. 4. *Musca australis* (male) ; fig. 5. *M. vetustissima* (male)
Fig. 6. *M. domestica* (male)—Brisbane specimen.

TEXT-FIGURES 7-11.

Fig. 7. Right wing of *M. australis* (male).
Fig. 8. Right wing of *M. vetustissima* (female).
Fig. 9. Right wing of *M. domestica* (female).
Fig. 10. Arista and antenna of *M. australis* (male).
Fig. 11. Arista and antenna of *M. vetustissima* (male).

TEXT-FIGURES 12-14.

All figures drawn to same scale.

Fig. 12. Female genitalia of *M. australis* (embryo removed from uterus).
Fig. 13. Female genitalia of *M. vetustissima.*
Fig. 14. Single ovariole of *M. vetustissima* containing nearly mature ovum.

TEXT-FIGURES 15-20.

All figures drawn to the same magnification.

Fig. 15. Anterior spiracle of mature larva of *M. vetustissima.*

Fig. 16. Anterior spiracle of mature larva of *M. australis.*

Fig. 17. Posterior spiracle of mature larva of *M. vetustissima.*

Fig. 18. Posterior spiracle of mature larva of *M. australis.*

Fig. 19. Posterior spiracle of second instar of *M. vetustissima.*

Fig. 20. Posterior spiracle of larva (second instar) from uterus of *M. australis.*

TEXT-FIGURES 21-26.

Fig. 21. Posterior spiracles of larva of *M. vetustissima* moulting from 2nd to 3rd instar, showing the two sets of spiracles, the larger developing below those of the second instar which are about to be thrown off.

Fig. 22. Posterior spiracles of first larval instar of *M. vetustissima.* Figs. 21 and 22 are drawn to the same scale.

Fig. 23. Posterior spiracle of 24 hours old larva of *M. australis* showing new spiracles of third instar developing below those of the second instar which are about to be cast off.

Fig. 24. Highly magnified view of two process of the anterior spiracle of a mature larva of *M. australis.*

Fig. 25. Puparium of *M. australis.*

Fig. 26. Puparium of *M. vetustissima.*

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